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John Cleese once famously quipped: *You don't need to be the Dalai Lama to tell people that life is about change*. This is reassuring, because I am not the Dalai Lama and I do intend to make the case that life and the skills needed to succeed at change are about emergence. As a father of two children and an educator with hundreds more entrusted to my care, I am increasingly concerned about equipping all of them for a future I cannot anticipate. In this article, I argue that complexity science, living systems theory, and self-organizing networks of community practice must become an essential part of every child's school experience if we are to attain a sustainable future. Moreover, I suggest that an anti-fragile teaching and learning perspective has the potential to shift human endeavor in a more sustainable direction and prepare the leaders of tomorrow for the challenges of the world around them.

Learning to Thrive in a Complex World

It doesn't take a philosopher-king to recognize that the world is complex and difficult to understand. For millennia, humans sought to make sense of their surroundings through proofs, heuristics, or theories. In the interlinked post-industrial realities of the information-age, these tools have become formidable in the scope of their focus and the depth of their predictive field. The reassuring authority of numbers surrounds us. I find it curious, however, that the depth and scope of the interlinking challenges faced by modern society have also intensified and deepened. While it is generally fair to say that more economic, scientific, and historical information is readily available than at any other point in human history, the panoramic view of the 21st century belies the fact that the full scope of the consequence of

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any given event remains obscured from view. Engineered systems for conveying information, or conducting the basic operations of human enterprise, have become so intertwined with one another that they are increasingly vulnerable to the cascading effects of disruptive episodes. As a result, no matter how attempts are made to offset the ripple of these shocks to the system as they bounce from interconnected node to interconnected node, the number of potential outcomes appears to grow exponentially, making them all but impossible to anticipate and avoid.

I love clocks and watches. Their tiny gears and precise movements fascinate me and tie deeply into an abiding interest in all things mechanical. Similarly, the metaphor of systems as mechanical devices, in which component pieces play defined roles, has a rather rationally-seductive quality about it, making it extremely popular in organizational theory. The metaphor is neat, tidy, and fits well with the schema of general common sense.

However, the universe is nothing like a watch. It is not a sealed steady-state system, free from external influence. Component pieces do not play fixed or rigidly-defined roles; nor are they subject to random events. Unlike springs and gears, they are influenced by the interplay of their proximity to one another in ways difficult to predict. Emergent advances in the field of scientific complexity theory suggest that the universe is not like a hierarchical organizational chart either. Its relationships are neither linear nor do they follow strict horizontal or vertical axes. There is no balanced ledger of cosmic inputs and outputs. In fact, it doesn't seem to operate at all like any of the models or metaphors we have tried to impose upon it for most of modern human history.

These ill-fitting mental schemas put the citizens of the 21st century at a disadvantage in the face of growing collective perils such as climate change and exponential population growth, and suggest that humanity needs to look elsewhere for an example that works. What do we do when the *going gets tough*? In recent years the idea of resiliency or robustness, as displayed by entire systems or by individual actors, has gained considerable traction. These concepts suggest that it is desirable to spring back or return to a normative state in the face of hardship or adversity and/or it is valuable to be cognitively bunkered in some sense, into a fortified position that has protective properties in the face of danger. Examples are drawn from concentration camps, football fields, hospital wards, and corporate boardrooms to reassure children in schools and affirm that they can make their way through whatever may lie ahead if they have the right combination of resolve, toughness, and elasticity. That is to say: *hunker down and, when the storm is over, come out of the foxhole and rebuild what existed before*.

Unfortunately, resolve, toughness, and elasticity may not be enough to prevail when the going really does get *unpredictably tough*, particularly in the face of repeated shocks to the individual or the collective system or when a return to the norm is simply no longer a possibility. As Austrian psychiatrist Viktor Frankl noted of his time as a prisoner in Auschwitz: "We have come back…we know the best

of us did not return" (Coutu, 2002, p. 9). The notion that, as Maurice Vanderpol (as cited in Coutu, 2002) suggests, someone has a *plastic shield* or is possessed of nerves of steel belies the fact that, under repeated stressors, material fatigue will set-in and result in structural failure. The metaphor of plastic elasticity or steely resilience is as problematic as it is pervasive: it implies an artificiality that does not reflect the challenges found in nature. Complex living systems alter and adapt when under stress, unlike non-living systems that falter, decline, or wear out. These systems routinely coalesce around key attractors, undergo dispersal in the face of instability, and then coalesce around new emergent attractors again (Morcol, 2006). This process of bifurcation and recombination is often messy and unpredictable, but it ultimately strengthens the agents involved because it casts off what has failed and builds upon what works. It is emergent, continuous, and moves with the flow of time. It is not about just getting back on-track; it is about perpetually building and re-building a new and improved path in concert with others.

The Search for Meaning, Critical Flexibility, and Personal Agency

If PK–12 schools really are to help the students in their quest for personal meaning and purpose, they must re-imagine themselves to provide authentic learning experiences for their children. To begin with, PK–12 educational policy makers must come to terms with the reality that purpose is not dictated to us by others, but is found within ourselves. Purpose is shaped and informed by direct life-experience and helps both individuals and groups find the opportunities embedded within the actual challenges they must confront and overcome. This suggests a shift from imparting essentialist or reductionist knowledge towards a focus on building/adding cognitive tools to the student's intellectual toolkit. As much as possible, each individual should strive, as the poet W.E. Henley (1875) advises, to be the *master of our fate and the captain of our soul*. This change implies that the process of social replication, often robed in the guise of citizenship, is insufficient in and of itself to safeguard humanity against potential future hazards. Humans are, or must become, rational actors who intentionally equip themselves to thrive in the face of emergent challenges. Future opportunities will be found by women and men possessed of a profound sense of personal agency, under which they shape and inform their own choices through critical analysis, adjustment, and transformation over time (Yanchar & Gabbitas, 2010).

Moving Beyond the Limitations of Resiliency

Life is lived under uncertain conditions, with emergent challenges and opportunities. The dynamic nature of the human experience requires us to exercise a degree of personal agency and critical flexibility, which are quite simply not found in traditional models of resiliency. When an event has reached the catastrophic threshold, it is not enough to respond and restore an *a priori* order. Although I am

reluctant to draw parallels between the worlds of business and education as their core purposes differ, Diane Coutu's analysis of investment giant Morgan Stanley's robust and resilient response to the attack on the New York World Trade Center in 2001 serves as a useful case in point. The attack itself might be best described as a "Black Swan"— a devastating event whose capricious consequences expose the weaknesses of both historical and predictive analytical defense systems (Taleb, 2010). According to Coutu (2002), Morgan Stanley had procedures and redundant systems in place that allowed it to get back to business and normalize its operations faster than most of its competitors. In lieu of genuine critical analysis, adjustment, and transformation it defaulted to a preset linear template and undertook to return to normative operations as swiftly as possible. Coutu (2002) celebrated Morgan Stanley's robustness, cited it as an excellent exemplar of the virtues of resiliency and said there was much to learn from their way of doing things.

I would argue that Morgan Stanley also serves as an excellent exemplar of the vices of resiliency as well. Oblivious to the effects of *causal opacity*, the state-of-the-art systems of traditional statistical analysis employed by Morgan Stanley and other large investment banks, combined with the robust comforts of past experience, allowed these institutions to plunge head-long into a second devastating "Black Swan" in the form of the sub-prime mortgage crisis of 2007, almost completely stalling the entire global economy in the process (Taleb, 2012). Morgan Stanley was stripped of over 80% of its market value, was compelled to convert to a traditional bank-holding company to access $10 billion from the Troubled Asset Relief Program (TARP), and sold a 21% ownership stake to the Mitsubishi UFJ Financial Group to obtain an additional $9 billion in emergency capital (Kudla, 2013). Morgan Stanley and many other titanic American finance and manufacturing companies *shattered* under the strain of a sub-prime manufactured "Black Swan" and would have failed to survive, save for the unprecedented intervention of the United States government.

It is important to understand that this event is situated in the context of the emergent realities of the global economy and was the direct result of the cumulative effects of routine, interlocked, and fragilized decision-making practices employed by the banking and investment sector (Taleb, 2012). It is no small irony that Morgan Stanley had to stop pretending it could predict the outcomes of high-risk ventures and establish a solid business core that limited its exposure to risk and interdependent frailty, while facilitating effective, sustainable growth to survive. Their action is the very thing all organisms must do to thrive and prosper in a complex universe.

Teaching and Learning from an Anti-fragile Perspective

I would argue that, as early 21st century citizens, we don't go nearly far enough to equip our children to meet the challenges they will face in the near-present and, by doing so, inadvertently imperil our collective future in the process. I propose that parents and educators begin (or perhaps rediscover how) to teach our children from

an *anti-fragile* perspective more in keeping with the emergent and adaptive nature of the universe (Taleb, 2012). I believe learning should take place in an environment that is safe, supportive, rigorous, and allows the possibility of transformative failure (Davis & Sumarra, 2012). Activities should be scaffolded; formative feedback should be looped; and powerful questions should guide the learning process (Friesen et al., 2013). The anti-fragile classroom is active, not passive, and is centered on building adaptive knowledge, not transmitting fixed facts.

As a parent, I believe my children's formative experiences should mimic the coalescent and bifurcative patterns of the universe, making them stronger, better, and more adaptive in the face of adversity. I want my children to develop a sense of agency and have opportunities to practice various forms of self-organization in shaping the multiple learning environments in which they find themselves (Dolan et al, 2013). They must be exposed to appropriate levels of *randomness, volatility, and acute stress* so they learn to improvise and adapt as needs dictate (Taleb, 2012). They must be made aware that, although the past is instructive, it does not perfectly predict the future. They must also come to understand that, although narratives can be immensely powerful in guiding our individual experiences, they are subject to a continuous cycle of reflective reinterpretation and/or *dimension reduction* which can be misleading, particularly when guided by others for their own purposes (Taleb, 2010, p. 71).

My children love judo and have been practicing it at our local YMCA for about three years. During that time I have come to realize that the judo dojo in many respects exemplifies an anti-fragile learning environment. The instruction is largely *flipped* (both in a literal and figurative sense) in that most of the class is spent doing, rather than listening or absorbing information. The environment, though safe and supportive, is tough and demanding. Students are taught to convert the punishing forces of momentum and gravity into elegant arcs and rolls. Aggression is channeled into discipline and competitiveness is tempered with mutual respect. Through the mechanisms of transformative failure and the self-strengthening properties of *Wolff's Law*, bones become denser, muscles become stronger, appropriate responses become reflexive, and thinking becomes improvisational and adaptive to the realities of each new circumstance (Taleb, 2012, p. 54). The curriculum of throws, break-falls, and holds is infinitely adapted in real time to meet the needs of the moment in an ever-emergent stream of improvisation. When my children are dramatically (if not heart-stoppingly) thrown to the mat and get back up, they are not merely resilient. They are made stronger; smarter; more adaptable. In that moment they have become anti-fragile.

It is important educators understand that, despite its adaptive rhetoric, resiliency promotes a return to the comfortable set point of familiarity as soon as possible, thereby causing systems and people to be brittle and inflexible, particularly in the face of unknowable repetitive stressors. Unlike all naturally occurring complex systems, resiliency doesn't inherently strengthen the actors involved. Its sunny

disposition belies a hidden hardscrabble meanness that was alluded to by Frankel: "…the best of us did not return" (Coutu, 2002, p. 10). Moreover, the linearity of resilient systems and their reliance on statistical modeling and its related predictive tools obscure the fact that the future is largely opaque, thereby exacerbating the effects of a range of "Black Swans" including: the organic-formation of a constellation of Jihadist terrorist cells, the death of up to 15,000 people at the hands of Ebola in western Africa, and the release of tons of radioactive material into the Pacific Ocean after the destruction of the Fukushima Daiichi Nuclear Power Plant (Miles, 2014; Taleb, 2012; Wheatley, 2007). Each of these events has had an unforeseen cascading effect on a range of interconnected nodes of human endeavor, resulting in a widespread loss of life, undue physical and psychological hardship for the individuals involved, and the unanticipated expenditure or loss of billions of dollars of public and private resources. In these instances, the system in which the examples were embedded was *fragile* and shattered when the *going got unpredictably tough*. All this begs the question: why would schools promote the schema of resiliency within which, *the best of us* are likely to perish?

The complex natural systems that abound throughout the universe require that educators impress a *complexified* understanding of the emergent nature of the world around us to exercise the personal agency required to dig out the opportunity embedded within each challenge. If one accepts that the future is largely opaque and unknowable, it becomes clear that humanity must reorganize itself along lines free from the fragility of resilient and robust defensive systems. We must, as Taleb (2012) suggests, become *anti-fragile*. This requires a complexified reconceptualization of the skill-sets needed to thrive and grow stronger in the face of adversity, which extends out well beyond the theoretical models implied by resiliency. It suggests a curriculum which sidesteps the potential perils of what Bertrand Russell called the *problem of inductive knowledge*, by recognizing that experience may actually take on a negative value in that what worked in the past may suddenly become irrelevant or viciously misleading by imposing a false map of stability on the likelihood of events (Taleb, 2010, p. 40).

In the absence of a genuine ability to foresee the future, methods must be found by which the effects of a "Black Swan" can be mitigated or turned to positive effect. Teaching and learning from an anti-fragile perspective would require that educational planners consider the *silent cemetery* of flora and fauna that departed the Earth without leaving traces in the form of fossils, suggesting that the existing record of biological winners is greatly outweighed by an extinction rate of up to 99.5% (Taleb, 2010, p. 108). Children need to be made aware that the human race has been *very lucky* and should try its best to conserve what has been gained largely through random chance (Taleb, 2010, p. 117).

Meeting the Challenges of an Uncertain Future

As parents and educators, we must equip children to be citizens of a future world

we cannot anticipate, by providing them with the best philosophical and cognitive tools possible. I don't want my son or daughter to build Vanderpol's *plastic shield* and attempt to deflect unpredictable Black Swans with it. I want them to build a spider's web: an emergent, elegantly-adaptive work in progress that is five-times stronger than steel and stands ever-ready to trap opportunities, both great and small, that come its way (North Carolina Museum of Natural Sciences, n.d.). The human race will need to confront the direct effects of environmental climate change and population growth in the near-immediate future. It does not serve our interest to continue to enter into low-return/high loss-potential scenarios, which are akin to "collecting nickels in the path of a steamroller" (Taleb, 2010, p. 204). Complexity science, living systems theory, and self-organizing networks of community practice are essential tools and must be considered an indispensable part of every child's school experience if we are ever to attain a sustainable future. An anti-fragile teaching and learning perspective has the potential to shift human endeavor. Anything less will fail to prepare students for the challenges of the real world around them.

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